

Appendix

Ultra-processed food consumption, cancer risk and cancer mortality: a large-scale prospective analysis within the UK Biobank

Kiara Chang, Marc J. Gunter, Fernanda Rauber, Renata B. Levy, Inge Huybrechts,
Nathalie Kliemann, Christopher Millett, Eszter P. Vamos

Table S1: Coding and number of site-specific cancer incident cases among UK Biobank participants	2
Table S2: Coding and number of site-specific cancer-related deaths among UK Biobank participants	4
Figure S1: Flow diagram for the derivation of study cohort	5
Figure S2: Covariate adjustments for the association between UPF consumption (per 10 percentage points) and cancer incidence.....	6
Table S3: Sensitivity analyses for the association between UPF consumption (per 10 percentage points) and cancer incidence	7
Table S4: Results of stratified analysis for head and neck and lung cancer outcomes.....	9
Figure S3: Covariate adjustments for the association between UPF consumption (per 10 percentage points) and cancer-related mortality	10
Table S5: Sensitivity analyses for the association between UPF consumption (per 10 percentage points) and cancer-related mortality.....	11
Figure S4: Sources of NOVA subgroups based on total energy intake by quartile of UPF consumption	13
Table S6: Association of cancer incidence by levels of UPF consumption based on total energy intake	14
Table S7: Association of cancer-related mortality by levels of UPF consumption based on total energy intake	16

Table S1: Coding and number of site-specific cancer incident cases among UK Biobank participants

Cancer site	ICD-10	ICD-O-3 morphology codes	Number of incident cases	Cases per 1000 person-years
All cancers (excl. C44 non-melanoma skin cancer)	C00-C97		15921	8·42
Head and Neck	C00-C14, C30-C32		342	0·18
Oral cavity	C02-C06		106	0·06
Oropharynx	C09-C10		86	0·05
Hypopharynx	C13		4	0·002
Larynx	C32		33	0·02
Gastrointestinal	C15-C26		2937	1·55
Oesophagus	C15		283	0·15
Adenocarcinoma	C15	8140, 8141, 8143, 8144, 8145, 8190, 8200, 8201, 8210, 8211, 8213, 8214, 8215, 8220, 8221, 8230, 8231, 8260, 8261, 8262, 8263, 8310, 8410, 8480, 8481, 8482, 8490, 8550, 8551, 8570, 8571, 8572, 8573, 8574, 8576	186	0·10
Squamous cell carcinoma (SCC)	C15	8050, 8052, 8070, 8071, 8072, 8073, 8074, 8075, 8076, 8078, 8083, 8084	67	0·04
Stomach	C16		189	0·10
Stomach cardia	C160		75	0·04
Stomach non-cardia	C161-C166		48	0·03
Small intestine	C17		77	0·04
Colorectal	C18-C20		1670	0·88
Colon	C18		1091	0·58
Rectum	C19-C20		579	0·31
Anal	C21		60	0·03
Hepatobiliary tract	C22-C24		243	0·13
Liver	C22		157	0·08
Hepatocellular carcinoma (HCC)	C220	8170, 8171, 8172, 8173, 8174, 8175	74	0·04
Intrahepatic bile duct	C221		67	0·04
Pancreas	C25	Any except 8150, 8151, 8153, 8155, 8240, 8246, 9591	386	0·20
Lung (including trachea and bronchus)	C33-C34		935	0·49
Melanoma skin	C43	8720, 8721, 8722, 8723, 8728, 8730, 8740, 8741, 8742, 8743, 8744, 8745, 8746, 8761, 8770, 8772, 8773, 8774, 8780	974	0·52
Kidney	C64-C65		451	0·24
Kidney, except renal pelvis	C64		413	0·22
Renal pelvis	C65		38	0·02
Renal cell carcinoma (RCC)	C64		8312	130
Bladder	C67		320	0·17

Table S1 (continued)

Cancer site	ICD-10	ICD-O-3 morphology codes	Number of incident cases	Cases per 1000 person-years
Brain and central nervous system	C70-C72		284	0·15
Brain	C71		277	0·15
Glioma		9380, 9381, 9382, 9390, 9391, 9392, 9393, 9395, 9400, 9401, 9411, 9420, 9423, 9424, 9425, 9430, 9440, 9441, 9442, 9445, 9451, 9460, 9470, 9471, 9472, 9473, 9474, 9480	242	0·13
Thyroid	C73		126	0·07
Lymphatic and haematopoietic tissue	C81-C96		1429	0·76
Non-Hodgkin lymphoma		9590, 9591, 9596, 9597, 9670, 9671, 9673, 9675, 9678, 9679, 9680, 9684, 9687, 9688, 9689, 9690, 9691, 9695, 9698, 9699, 9700, 9701, 9702, 9705, 9708, 9709, 9712, 9714, 9716, 9717, 9718, 9719, 9726, 9727, 9728, 9729, 9731, 9732, 9733, 9734, 9735, 9737, 9738, 9760, 9761, 9764, 9820, 9823, 9826, 9827, 9831, 9832, 9833, 9834, 9835, 9836, 9837, 9940, 9948	1091	0·58
Diffuse large B-cell lymphoma (DLBCL)		9678, 9679, 9680, 9684, 9688, 9712, 9735, 9737, 9738	210	0·11
Follicular lymphoma (FL)		9690, 9691, 9695, 9698	154	0·08
Chronic lymphocytic leukemia/Small lymphocytic lymphoma (CLL/SLL)		9670, 9823	226	0·12
Marginal-zone lymphoma (MZL)		9689, 9699, 9760, 9764	1	0·001
Multiple myeloma	C90		286	0·15
Leukaemia	C91-C95		400	0·21
Breast	C50		3053	2·93
Pre-menopausal breast	C50		717	0·69
Post-menopausal breast	C50		1856	1·78
Cervical	C53		36	0·03
Uterus	C54-C55		439	0·42
Endometrium	C54		429	0·41
Ovary	C56		291	0·28
Prostate	C61		3621	4·27

Table S2: Coding and number of site-specific cancer-related deaths among UK Biobank participants

Cancer site	ICD-10	Number of deaths	Deaths per 1000 person-years
All cancers (excl. C44 non-melanoma skin cancer)	C00-C97	4009	2.05
Head and Neck	C00-C14, C30-C32	54	0.03
Oral cavity	C02-C06	18	0.01
Oropharynx	C09-C10	11	0.01
Hypopharynx	C13	4	0.002
Larynx	C32	8	0.004
Gastrointestinal	C15-C26	1408	0.72
Oesophagus	C15	194	0.10
Stomach	C16	121	0.06
Stomach cardia	C160	24	0.01
Stomach non-cardia	C161-C166	1	0.001
Small intestine	C17	20	0.01
Colorectal	C18-C20	438	0.22
Colon	C18	244	0.12
Rectum	C19-C20	194	0.10
Anal	C21	11	0.01
Hepatobiliary tract	C22-C24	182	0.09
Liver	C22	150	0.08
Hepatocellular carcinoma (HCC)	C220	46	0.02
Intrahepatic bile duct	C221	103	0.05
Pancreas	C25	371	0.19
Lung (including trachea and bronchus)	C33-C34	633	0.32
Melanoma skin	C43	63	0.03
Kidney	C64-C65	117	0.06
Kidney, except renal pelvis	C64	115	0.06
Renal pelvis	C65	2	0.001
Bladder	C67	112	0.06
Brain and central nervous system	C70-C72	251	0.13
Brain	C71	250	0.13
Thyroid	C73	8	0.004
Lymphatic & haematopoietic tissue	C81-C96	376	0.19
Non-Hodgkin lymphoma	C82-C85	141	0.07
Multiple myeloma	C90	91	0.05
Leukaemia	C91-C95	137	0.07
Breast	C50	176	0.16
Pre-menopausal breast	C50	30	0.03
Post-menopausal breast	C50	120	0.11
Cervical	C53	8	0.01
Uterus	C54-C55	61	0.06
Endometrium	C54	43	0.04
Ovary	C56	143	0.13
Prostate	C61	194	0.22

Figure S1: Flow diagram for the derivation of study cohort

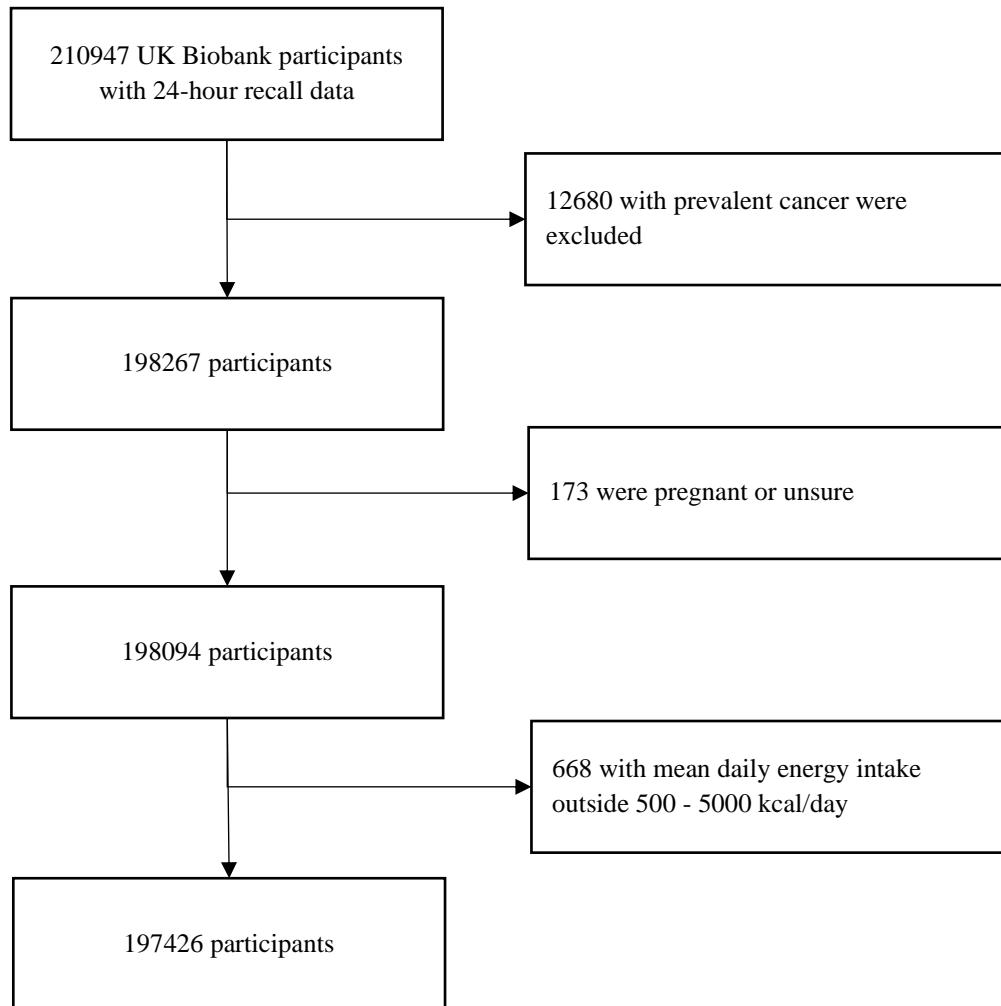
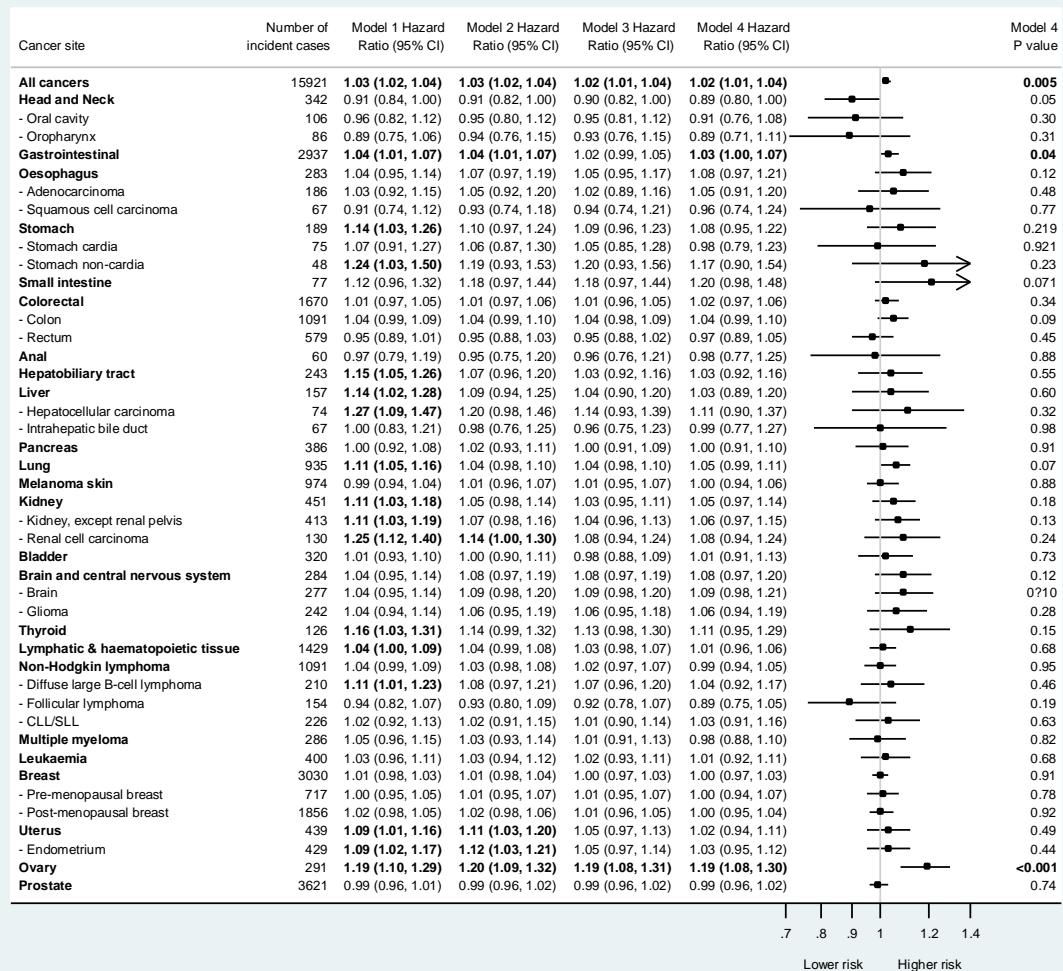


Figure S2: Covariate adjustments for the association between UPF consumption (per 10 percentage points) and cancer incidence



Abbreviations: UPF, ultra-processed food; CI, confidence interval; CLL, Chronic lymphocytic leukemia; SLL, Small lymphocytic lymphoma.

UPF consumption was defined as the percentage of its weight contribution relative to total food intake measured in g/day. Model results are interpreted as hazard ratio for every 10 percentage points increment in the UPF content of total diet. Model 1 included age (underlying timescale), and stratified by sex. Model 2 additionally included ethnicity, smoking status, physical activity level, average household income, highest educational attainment, alcohol intake, and additionally stratified by height, family history of cancer, index of multiple deprivation quintile, and geographical region. Female-specific cancer outcomes were additionally adjusted for baseline menopausal status, use of oral contraceptives, use of hormone replacement therapy, and parity. Model 3 additionally included body mass index category. Model 4 additionally included total daily energy intake. Analysis for risk of breast, uterus and ovarian cancers were conducted in women only (n=107919) and risk of prostate cancer was conducted in men only (n= 89507).

Table S3: Sensitivity analyses for the association between UPF consumption (per 10 percentage points) and cancer incidence

Cancer Site	Model S1 HR (95% CI)	Model S2 HR (95% CI)	Model S3 HR (95% CI)	Model S4 HR (95% CI)	Model S5 HR (95% CI)	Model S6 HR (95% CI)	Model S7 HR (95% CI)
All cancers	1.02 (1.00-1.03)§	1.02 (1.00-1.03)‡	1.01 (1.00-1.03)‡	1.02 (1.00-1.03)§	1.01 (1.00-1.03)‡	1.02 (1.00-1.03)§	1.02 (1.00-1.04)§
Head and Neck	0.89 (0.80-1.00)	0.88 (0.79-1.00)	0.90 (0.81-1.01)	0.89 (0.80-0.99)‡	0.89 (0.80-1.00)	0.90 (0.81-1.00)	0.91 (0.81-1.03)
Oral cavity	0.91 (0.75-1.09)	0.90 (0.74-1.08)	0.93 (0.77-1.12)	0.90 (0.75-1.08)	0.90 (0.75-1.08)	0.91 (0.76-1.08)	0.94 (0.78-1.15)
Oropharynx	0.88 (0.70-1.11)	0.87 (0.69-1.10)	0.87 (0.69-1.10)	0.90 (0.71-1.13)	0.89 (0.71-1.12)	0.90 (0.72-1.13)	0.92 (0.71-1.19)
Gastrointestinal	1.03 (1.00-1.07)‡	1.03 (1.00-1.07)‡	1.03 (0.99-1.07)	1.03 (1.00-1.07)‡	1.02 (0.99-1.06)	1.03 (1.00-1.06)‡	1.03 (0.99-1.07)
Oesophagus	1.10 (0.98-1.23)	1.09 (0.97-1.22)	1.05 (0.94-1.18)	1.08 (0.97-1.21)	1.08 (0.97-1.20)	1.08 (0.97-1.21)	1.02 (0.90-1.15)
Adenocarcinoma	1.05 (0.91-1.21)	1.04 (0.89-1.20)	1.00 (0.86-1.15)	1.05 (0.91-1.20)	1.03 (0.90-1.18)	1.05 (0.91-1.20)	1.01 (0.86-1.18)
Squamous cell carcinoma	1.03 (0.79-1.34)	0.97 (0.73-1.29)	0.95 (0.72-1.25)	0.93 (0.71-1.22)	0.96 (0.74-1.25)	0.95 (0.73-1.25)	0.81 (0.60-1.11)
Stomach	1.08 (0.94-1.23)	1.10 (0.96-1.26)	1.11 (0.97-1.27)	1.08 (0.95-1.23)	1.08 (0.95-1.23)	1.08 (0.95-1.22)	1.05 (0.91-1.21)
Stomach cardia	0.98 (0.78-1.23)	1.01 (0.80-1.27)	1.03 (0.82-1.30)	0.99 (0.79-1.24)	0.99 (0.79-1.24)	0.98 (0.79-1.23)	1.05 (0.83-1.34)
Stomach non-cardia	1.14 (0.86-1.51)	1.12 (0.83-1.50)	1.17 (0.88-1.55)	1.19 (0.90-1.56)	1.17 (0.89-1.54)	1.17 (0.89-1.54)	1.08 (0.80-1.47)
Small intestine	1.22 (0.99-1.51)	1.20 (0.96-1.50)	1.16 (0.94-1.45)	1.21 (0.98-1.49)	1.21 (0.98-1.49)	1.22 (0.99-1.50)	1.08 (0.84-1.38)
Colorectal	1.01 (0.96-1.05)	1.01 (0.96-1.06)	1.02 (0.97-1.07)	1.02 (0.98-1.07)	1.01 (0.97-1.06)	1.02 (0.97-1.06)	1.03 (0.98-1.08)
Colon	1.03 (0.97-1.09)	1.04 (0.98-1.10)	1.05 (0.99-1.12)	1.05 (0.99-1.11)	1.04 (0.98-1.10)	1.04 (0.99-1.10)	1.05 (0.99-1.12)
Rectum	0.95 (0.88-1.04)	0.94 (0.87-1.03)	0.95 (0.87-1.03)	0.97 (0.90-1.05)	0.96 (0.89-1.04)	0.97 (0.89-1.04)	0.99 (0.91-1.08)
Anal	0.94 (0.73-1.21)	0.97 (0.75-1.25)	1.00 (0.77-1.29)	1.00 (0.78-1.27)	0.96 (0.75-1.24)	0.99 (0.77-1.27)	1.02 (0.78-1.35)
Hepatobiliary tract	1.05 (0.93-1.18)	1.06 (0.94-1.20)	1.05 (0.92-1.18)	1.02 (0.90-1.15)	1.02 (0.90-1.15)	1.03 (0.92-1.16)	1.04 (0.92-1.19)
Liver	1.05 (0.90-1.22)	1.08 (0.93-1.26)	1.04 (0.89-1.21)	1.03 (0.88-1.19)	1.01 (0.87-1.18)	1.04 (0.90-1.20)	1.04 (0.89-1.23)
Hepatocellular carcinoma	1.10 (0.88-1.37)	1.12 (0.89-1.40)	1.07 (0.84-1.35)	1.09 (0.87-1.36)	1.09 (0.88-1.36)	1.11 (0.90-1.37)	1.10 (0.88-1.37)
Intrahepatic bile duct	1.03 (0.80-1.33)	1.08 (0.83-1.40)	1.02 (0.79-1.33)	0.99 (0.77-1.28)	0.98 (0.76-1.26)	0.99 (0.77-1.28)	0.97 (0.73-1.28)
Pancreas	1.03 (0.93-1.13)	1.02 (0.92-1.13)	0.99 (0.90-1.10)	1.00 (0.91-1.10)	1.00 (0.90-1.10)	1.00 (0.91-1.10)	0.99 (0.90-1.10)
Lung	1.06 (0.99-1.12)	1.04 (0.98-1.11)	1.05 (0.98-1.11)	1.05 (0.99-1.11)	1.04 (0.98-1.11)	1.05 (0.99-1.11)	1.09 (1.03-1.16)§
Melanoma skin	1.01 (0.95-1.07)	1.00 (0.94-1.06)	1.00 (0.94-1.06)	1.00 (0.94-1.06)	1.00 (0.94-1.06)	1.00 (0.94-1.06)	1.00 (0.93-1.07)
Kidney	1.05 (0.97-1.14)	1.04 (0.95-1.13)	1.02 (0.94-1.11)	1.06 (0.98-1.15)	1.04 (0.96-1.12)	1.05 (0.97-1.13)	1.08 (0.99-1.18)
Kidney, except renal pelvis	1.06 (0.97-1.16)	1.04 (0.95-1.14)	1.04 (0.95-1.14)	1.07 (0.98-1.17)	1.05 (0.96-1.14)	1.06 (0.97-1.15)	1.11 (1.01-1.22)‡
Renal cell carcinoma	1.07 (0.93-1.24)	1.03 (0.89-1.20)	1.09 (0.94-1.26)	1.09 (0.94-1.25)	1.06 (0.92-1.22)	1.09 (0.95-1.25)	1.14 (0.97-1.35)
Bladder	1.03 (0.93-1.15)	1.02 (0.91-1.14)	1.02 (1.02-1.14)	1.00 (0.90-1.12)	1.01 (0.91-1.12)	1.01 (0.91-1.13)	1.02 (0.90-1.15)
Brain and central nervous system	1.08 (0.96-1.20)	1.07 (0.96-1.20)	1.06 (0.95-1.19)	1.10 (0.98-1.22)	1.08 (0.97-1.20)	1.08 (0.97-1.20)	1.08 (0.96-1.22)
Brain	1.08 (0.97-1.21)	1.08 (0.96-1.21)	1.07 (0.95-1.20)	1.10 (0.99-1.23)	1.09 (0.98-1.21)	1.08 (0.97-1.21)	1.09 (0.97-1.23)
Glioma	1.05 (0.94-1.19)	1.05 (0.93-1.19)	1.05 (0.93-1.18)	1.08 (0.96-1.21)	1.06 (0.94-1.19)	1.06 (0.94-1.18)	1.06 (0.94-1.21)
Thyroid	1.15 (0.99-1.35)	1.12 (0.95-1.32)	1.05 (0.89-1.23)	1.11 (0.95-1.29)	1.12 (0.96-1.30)	1.11 (0.95-1.29)	1.20 (1.02-1.41)‡
Lymphatic & haematopoietic tissue	1.01 (0.96-1.06)	1.00 (0.95-1.05)	1.00 (0.95-1.06)	1.00 (0.95-1.05)	1.00 (0.96-1.05)	1.00 (0.96-1.05)	1.00 (0.95-1.06)
Non-Hodgkin lymphoma	1.00 (0.94-1.06)	0.99 (0.93-1.05)	0.99 (0.94-1.05)	0.99 (0.94-1.05)	0.99 (0.94-1.05)	0.99 (0.94-1.05)	0.98 (0.92-1.04)
Diffuse large B-cell lymphoma	1.03 (0.91-1.16)	1.04 (0.91-1.18)	1.03 (0.91-1.16)	1.04 (0.92-1.17)	1.04 (0.92-1.17)	1.04 (0.92-1.17)	1.03 (0.91-1.18)
Follicular lymphoma	0.88 (0.74-1.05)	0.87 (0.73-1.04)	0.90 (0.75-1.07)	0.87 (0.74-1.04)	0.88 (0.74-1.04)	0.90 (0.76-1.06)	0.85 (0.70-1.03)
CLL/SLL	1.04 (0.92-1.17)	1.03 (0.90-1.17)	1.02 (0.90-1.16)	1.03 (0.91-1.16)	1.03 (0.91-1.16)	1.02 (0.91-1.16)	1.00 (0.87-1.15)
Multiple myeloma	1.01 (0.90-1.13)	0.96 (0.85-1.08)	0.97 (0.87-1.09)	0.99 (0.88-1.10)	0.99 (0.88-1.10)	0.98 (0.88-1.10)	0.99 (0.88-1.12)
Leukaemia	1.01 (0.92-1.11)	1.03 (0.93-1.14)	1.02 (0.92-1.12)	1.01 (0.92-1.11)	1.01 (0.92-1.11)	1.01 (0.92-1.11)	1.02 (0.92-1.13)
Breast†	1.00 (0.96-1.03)	1.00 (0.97-1.04)	0.99 (0.96-1.03)	1.00 (0.96-1.03)	1.00 (0.96-1.03)	1.00 (0.97-1.03)	1.00 (0.96-1.04)
Pre-menopausal breast†	1.00 (0.94-1.07)	1.01 (0.95-1.09)	1.01 (0.95-1.08)	1.00 (0.94-1.07)	1.00 (0.94-1.07)	1.01 (0.94-1.07)	1.00 (0.93-1.08)
Post-menopausal breast†	1.00 (0.95-1.05)	0.99 (0.94-1.04)	1.00 (0.95-1.04)	1.00 (0.95-1.04)	1.00 (0.95-1.04)	1.00 (0.95-1.04)	1.00 (0.95-1.05)
Uterus†	1.01 (0.93-1.11)	1.03 (0.94-1.12)	1.02 (0.94-1.12)	1.02 (0.94-1.11)	1.02 (0.94-1.11)	1.02 (0.94-1.11)	1.06 (0.96-1.16)
Endometrium†	1.02 (0.93-1.11)	1.03 (0.94-1.13)	1.02 (0.94-1.12)	1.03 (0.94-1.12)	1.03 (0.95-1.12)	1.03 (0.94-1.12)	1.06 (0.96-1.16)
Ovary†	1.15 (1.03-1.27)§	1.12 (1.01-1.25)‡	1.16 (1.05-1.29)§	1.16 (1.05-1.28)§	1.16 (1.05-1.28)§	1.16 (1.05-1.28)§	1.17 (1.05-1.31)§
Prostate†	0.99 (0.95-1.02)	0.99 (0.95-1.02)	0.99 (0.96-1.02)	0.99 (0.95-1.02)	0.99 (0.96-1.02)	0.99 (0.96-1.02)	0.99 (0.96-1.03)

Abbreviations: UPF, ultra-processed food; HR, hazard ratio; CI, confidence interval; CLL, Chronic lymphocytic leukemia; SLL, Small lymphocytic lymphoma.

All models were based on the final model and fully adjusted with age (underlying timescale), ethnicity, smoking status, physical activity level, average household income, highest educational attainment, alcohol intake, body mass index, total daily energy intake, and stratified by sex, height, family history of cancer, index of multiple deprivation quintile, and geographical region.

Analyses of female-specific cancers were additionally adjusted for baseline menopausal status, use of oral contraceptives, use of hormone replacement therapy, and parity.

UPF consumption was defined as the percentage of its weight contribution relative to total food intake measured in g/day. Model results are interpreted as hazard ratio for every 10 percentage points increment in the UPF content of total diet.

Model S1 had total energy intake removed from the final model but additionally adjusted for sodium, total fat, and carbohydrate intake. Colorectal cancer outcomes were additionally adjusted for red meat, processed meat, fibre, and calcium intake.

Model S2 had total energy intake removed from the final model but additionally adjusted for sodium, trans fat, and free sugars intake. Colorectal cancer outcomes were additionally adjusted for red meat, processed meat, fibre, and calcium intake. Results were consistent when intake of saturated fat was adjusted for instead of trans fat. Intake of trans fat and saturated fat were not included in the model simultaneously due to high correlation coefficient (0.79).

Model S3 was additionally adjusted for fruit and vegetable intake.

Model S4 had alcohol intake removed from the derivation of UPF consumption and total energy intake.

Model S5 was additionally adjusted for baseline presence of diabetes, cardiovascular disease, depression, and high blood pressure.

Model S6 was additionally adjusted for number of 24-hour recalls.

Model S7 excluded participants with follow-up time <2 years (n=193878).

†Modelling for breast, uterus and ovarian cancers were conducted in women only (n=107919), modelling for prostate cancer were conducted in men only (n= 89507).

‡ $P < 0.05$

§ $P < 0.01$

Table S4: Results of stratified analysis for head and neck and lung cancer outcomes

Head and Neck cancer [†]	case/N	per 10% increment in UPF intake ^b HR (95% CI)	Quartile of UPF consumption*				<i>P</i> _{Trend}
			Q1 (lowest) Ref	Q2 HR (95% CI)	Q3 HR (95% CI)	Q4 (highest) HR (95% CI)	
Incidence by smoking status							
Never smoked	158/111814	0.84 (0.69-1.02)	1	1.03 (0.60-1.77)	0.65 (0.35-1.19)	0.57 (0.29-1.13)	0.05
Ex-smoker	482/69545	0.87 (0.72-1.04)	1	0.61 (0.34-1.07)	0.61 (0.34-1.08)	0.60 (0.32-1.12)	0.12
Current smoker	292/15622	1.05 (0.76-1.47)	1	1.51 (0.38-5.96)	1.01 (0.24-4.19)	1.06 (0.27-4.05)	0.98
Incidence by alcohol consumption[‡]							
Non-consumer of alcohol	55/36784	0.82 (0.58-1.15)	1	0.40 (0.10-1.49)	0.51 (0.14-1.77)	0.64 (0.18-2.24)	0.63
Low alcohol consumer	113/78890	0.90 (0.75-1.08)	1	0.83 (0.43-1.60)	0.51 (0.26-1.01)	0.49 (0.23-1.00)	0.02
High alcohol consumer	174/81752	0.95 (0.79-1.14)	1	0.64 (0.40-1.04)	0.61 (0.36-1.04)	0.74 (0.41-1.34)	0.18
Lung cancer	case/N	per 10% increment in UPF intake ^b HR (95% CI)	Quartile of UPF consumption*				<i>P</i> _{Trend}
			Q1 (lowest) Ref	Q2 HR (95% CI)	Q3 HR (95% CI)	Q4 (highest) HR (95% CI)	
Incidence by smoking status							
Never smoked	158/111814	0.94 (0.80-1.11)	1	1.02 (0.61-1.69)	0.94 (0.56-1.59)	0.92 (0.51-1.63)	0.74
Ex-smoker	482/69545	1.07 (0.97-1.17)	1	0.97 (0.71-1.31)	0.83 (0.60-1.15)	1.30 (0.94-1.80)	0.22
Current smoker	292/15622	1.05 (0.90-1.22)	1	1.26 (0.69-2.31)	1.24 (0.66-2.30)	1.26 (0.68-2.32)	0.50
Mortality by smoking status							
Never smoked	88/111814	1.00 (0.79-1.27)	1	1.48 (0.75-2.91)	0.85 (0.40-1.80)	1.19 (0.54-2.60)	0.95
Ex-smoker	323/69545	1.10 (0.98-1.23)	1	1.01 (0.69-1.47)	1.01 (0.68-1.50)	1.43 (0.95-2.14)	0.09
Current smoker	220/15622	1.10 (0.93-1.30)	1	1.09 (0.55-2.14)	1.23 (0.60-2.49)	1.25 (0.63-2.48)	0.48

Abbreviations: UPF, ultra-processed food; HR, hazard ratio; CI, confidence interval; Ref, reference category.

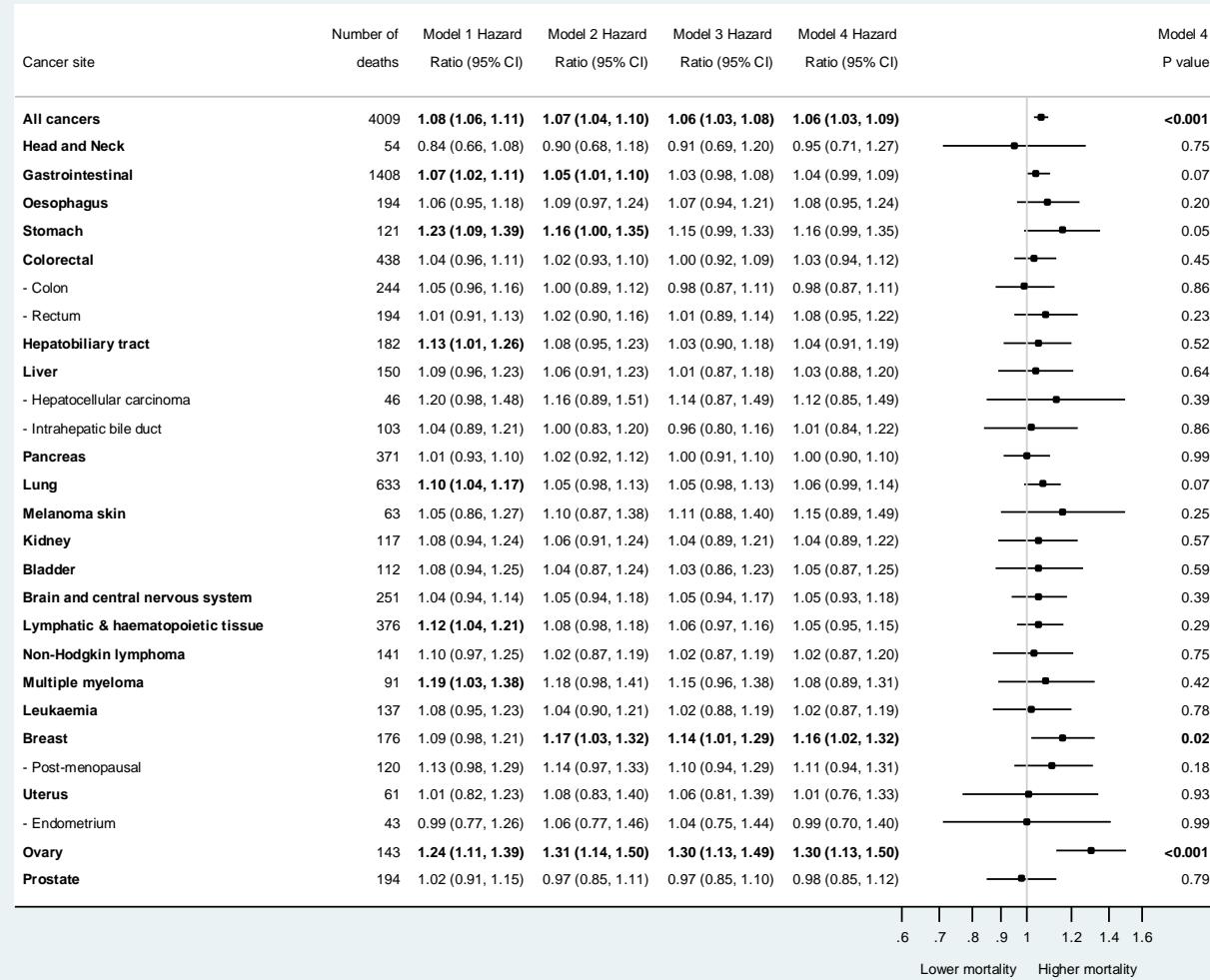
All models were fully adjusted with age (underlying timescale), ethnicity, smoking status (removed from analyses stratified by the same variable), physical activity level, average household income, highest educational attainment, alcohol intake, body mass index, total daily energy intake, and stratified by sex, height, family history of cancer, index of multiple deprivation quintile, and geographical region.

*UPF consumption was defined as the percentage of its weight contribution relative to total food intake measured in g/day. Study participants were further categorized into quartiles (Q1-Q4 represents lowest to highest quartile of UPF consumption).

†Stratified analysis for head and neck cancer mortality was not performed due to small case number in subgroups ($n < 20$).

‡Alcohol consumption groups were defined as: non-consumer (0g/day); low alcohol consumer (<17g/day); high alcohol consumer (≥ 17 g/day). The median alcohol consumption was 17g/day among those consumed alcohol in the study cohort.

Figure S3: Covariate adjustments for the association between UPF consumption (per 10 percentage points) and cancer-related mortality



Abbreviations: UPF, ultra-processed food; CI, confidence interval.

UPF consumption was defined as the percentage of its weight contribution relative to total food intake measured in g/day. Model results are interpreted as hazard ratio for every 10 percentage points increment in the UPF content of total diet. Model 1 included age (underlying timescale), and stratified by sex. Model 2 additionally included ethnicity, smoking status, physical activity level, average household income, highest educational attainment, alcohol intake, and additionally stratified by height, family history of cancer, index of multiple deprivation quintile, and geographical region. Female-specific cancer outcomes were additionally adjusted for baseline menopausal status, use of oral contraceptives, use of hormone replacement therapy, and parity. Model 3 additionally included body mass index category. Model 4 additionally included total daily energy intake. Analysis for risk of breast, uterus and ovarian cancers were conducted in women only (n=107919) and risk of prostate cancer was conducted in men only (n= 89507).

Table S5: Sensitivity analyses for the association between UPF consumption (per 10 percentage points) and cancer-related mortality

Cancer site	Model S1 HR (95% CI)	Model S2 HR (95% CI)	Model S3 HR (95% CI)	Model S4 HR (95% CI)	Model S5 HR (95% CI)	Model S6 HR (95% CI)	Model S7 HR (95% CI)
All cancer	1.05 (1.02-1.09)¶	1.05 (1.02-1.08)§	1.05 (1.02-1.08)¶	1.06 (1.03-1.09)¶	1.05 (1.02-1.08)¶	1.06 (1.03-1.09)¶	1.06 (1.03-1.09)¶
Head and Neck	0.95 (0.70-1.29)	0.94 (0.68-1.29)	0.90 (0.67-1.22)	0.94 (0.70-1.27)	0.95 (0.71-1.27)	0.97 (0.72-1.29)	0.99 (0.74-1.33)
Gastrointestinal	1.04 (0.99-1.10)	1.04 (0.99-1.10)	1.03 (0.98-1.09)	1.04 (0.99-1.09)	1.03 (0.98-1.08)	1.04 (0.99-1.09)	1.04 (0.99-1.09)
Oesophagus	1.10 (0.96-1.26)	1.08 (0.94-1.25)	1.08 (0.94-1.24)	1.08 (0.94-1.23)	1.08 (0.94-1.23)	1.08 (0.95-1.23)	1.06 (0.93-1.22)
Stomach	1.18 (1.00-1.38)‡	1.20 (1.01-1.42)‡	1.17 (1.00-1.38)‡	1.17 (1.00-1.36)‡	1.18 (1.00-1.38)‡	1.15 (0.99-1.34)	1.12 (0.95-1.33)
Colorectal	0.98 (0.89-1.08)	0.99 (0.90-1.09)	1.02 (0.93-1.12)	1.03 (0.94-1.13)	1.02 (0.94-1.12)	1.03 (0.94-1.12)	1.04 (0.95-1.14)
Colon	0.93 (0.82-1.06)	0.95 (0.83-1.08)	0.99 (0.88-1.13)	0.99 (0.88-1.12)	0.97 (0.86-1.10)	0.99 (0.88-1.12)	1.01 (0.89-1.15)
Rectum	1.05 (0.91-1.20)	1.06 (0.92-1.22)	1.05 (0.92-1.20)	1.07 (0.94-1.22)	1.07 (0.94-1.22)	1.07 (0.94-1.21)	1.08 (0.95-1.23)
Hepatobiliary tract	1.05 (0.91-1.21)	1.05 (0.91-1.22)	1.03 (0.89-1.19)	1.04 (0.90-1.19)	1.04 (0.90-1.19)	1.04 (0.91-1.19)	1.04 (0.90-1.20)
Liver	1.05 (0.89-1.22)	1.05 (0.89-1.24)	1.01 (0.86-1.19)	1.02 (0.87-1.20)	1.03 (0.88-1.20)	1.03 (0.88-1.20)	1.04 (0.88-1.22)
Hepatocellular carcinoma	1.12 (0.84-1.49)	1.12 (0.83-1.49)	1.06 (0.78-1.43)	1.11 (0.82-1.49)	1.12 (0.84-1.51)	1.10 (0.83-1.44)	1.15 (0.86-1.52)
Intrahepatic bile duct	1.03 (0.85-1.25)	1.05 (0.85-1.29)	1.01 (0.83-1.24)	1.01 (0.83-1.23)	1.00 (0.82-1.21)	1.02 (0.84-1.23)	1.01 (0.83-1.24)
Pancreas	1.02 (0.92-1.12)	1.01 (0.91-1.12)	1.00 (0.90-1.10)	0.99 (0.90-1.10)	0.99 (0.90-1.09)	1.00 (0.90-1.10)	1.00 (0.90-1.11)
Lung	1.05 (0.98-1.14)	1.05 (0.97-1.14)	1.06 (0.98-1.14)	1.06 (0.98-1.14)	1.06 (0.98-1.14)	1.06 (0.99-1.14)	1.09 (1.01-1.18)‡
Melanoma skin	1.09 (0.84-1.43)	1.09 (0.82-1.44)	1.08 (0.82-1.41)	1.17 (0.90-1.51)	1.16 (0.90-1.50)	1.16 (0.90-1.49)	1.06 (0.81-1.39)
Kidney	1.03 (0.87-1.21)	1.00 (0.83-1.19)	0.97 (0.82-1.16)	1.06 (0.90-1.25)	1.02 (0.87-1.21)	1.04 (0.88-1.22)	1.04 (0.87-1.23)
Bladder	1.02 (0.85-1.23)	1.03 (0.85-1.25)	1.04 (0.86-1.26)	1.03 (0.86-1.24)	1.05 (0.88-1.26)	1.04 (0.87-1.25)	1.03 (0.85-1.23)
Brain and central nervous system	1.03 (0.91-1.16)	1.03 (0.91-1.16)	1.05 (0.93-1.18)	1.07 (0.95-1.20)	1.05 (0.93-1.17)	1.04 (0.93-1.17)	1.04 (0.92-1.18)
Lymphatic & haematopoietic tissue	1.03 (0.94-1.14)	1.03 (0.93-1.15)	1.08 (0.98-1.20)	1.05 (0.95-1.16)	1.05 (0.95-1.15)	1.04 (0.95-1.15)	1.05 (0.95-1.15)
Non-Hodgkin lymphoma	0.99 (0.84-1.17)	0.99 (0.83-1.19)	1.06 (0.89-1.26)	1.03 (0.87-1.21)	1.01 (0.86-1.19)	1.02 (0.86-1.19)	1.01 (0.85-1.19)
Multiple myeloma	1.09 (0.89-1.33)	1.04 (0.84-1.29)	1.11 (0.90-1.37)	1.08 (0.88-1.32)	1.12 (0.92-1.38)	1.06 (0.87-1.30)	1.09 (0.90-1.33)
Leukaemia	1.00 (0.85-1.18)	1.02 (0.86-1.21)	1.05 (0.89-1.24)	1.02 (0.86-1.19)	1.02 (0.87-1.19)	1.02 (0.87-1.19)	1.03 (0.87-1.21)
Breast	1.15 (1.00-1.31)‡	1.15 (1.01-1.33)‡	1.13 (1.00-1.30)‡	1.16 (1.02-1.32)‡	1.16 (1.02-1.32)‡	1.16 (1.02-1.32)‡	1.19 (1.05-1.36)§
Post-menopausal	1.10 (0.93-1.31)	1.12 (0.93-1.35)	1.11 (0.93-1.32)	1.11 (0.94-1.32)	1.11 (0.95-1.31)	1.14 (0.96-1.35)	1.13 (0.96-1.34)
Uterus	1.01 (0.76-1.35)	1.00 (0.74-1.35)	0.97 (0.72-1.31)	1.01 (0.76-1.33)	1.01 (0.76-1.33)	0.99 (0.74-1.32)	1.01 (0.76-1.33)
Endometrium	0.96 (0.66-1.38)	0.94 (0.64-1.38)	0.89 (0.60-1.31)	1.00 (0.70-1.41)	0.97 (0.69-1.38)	0.97 (0.68-1.39)	0.98 (0.69-1.39)
Ovary	1.25 (1.08-1.45)§	1.26 (1.08-1.48)§	1.29 (1.11-1.50)§	1.30 (1.13-1.51)¶	1.31 (1.13-1.51)¶	1.29 (1.11-1.48)¶	1.28 (1.10-1.48)§
Prostate	0.97 (0.85-1.12)	0.95 (0.82-1.11)	0.99 (0.86-1.15)	0.98 (0.85-1.13)	0.97 (0.85-1.12)	0.98 (0.85-1.12)	0.96 (0.83-1.11)

Abbreviations: UPF, ultra-processed food; HR, hazard ratio; CI, confidence interval.

All models were based on the final model and fully adjusted with age (underlying timescale), ethnicity, smoking status, physical activity level, average household income, highest educational attainment, alcohol intake, body mass index, total daily energy intake, and stratified by sex, height, family history of cancer, index of multiple deprivation quintile, and geographical region.

Analyses of female-specific cancers were additionally adjusted for baseline menopausal status, use of oral contraceptives, use of hormone replacement therapy, and parity.

UPF consumption was defined as the percentage of its weight contribution relative to total food intake measured in g/day. Model results are interpreted as hazard ratio for every 10 percentage points increment in UPF content of total diet.

Model S1 had total energy intake removed from the final model but additionally adjusted for sodium, total fat, and carbohydrate intake. Colorectal cancer outcomes were additionally adjusted for red meat, processed meat, fibre, and calcium intake.

Model S2 had total energy intake removed from the final model but additionally adjusted for sodium, trans fat, and free sugars intake. Colorectal cancer outcomes were additionally adjusted for red meat, processed meat, fibre, and calcium intake. Results were consistent when intake of saturated fat was adjusted for instead of trans fat. Intake of trans fat and saturated fat were not included in the model simultaneously due to high correlation coefficient (0.79).

Model S3 was additionally adjusted for fruit and vegetable intake.

Model S4 had alcohol intake removed from the derivation of UPF consumption and total energy intake.

Model S5 was additionally adjusted for baseline presence of diabetes, cardiovascular disease, depression, and high blood pressure.

Model S6 was additionally adjusted for number of 24-hour recalls.

Model S7 excluded participants with follow-up time <2 years (n=196657).

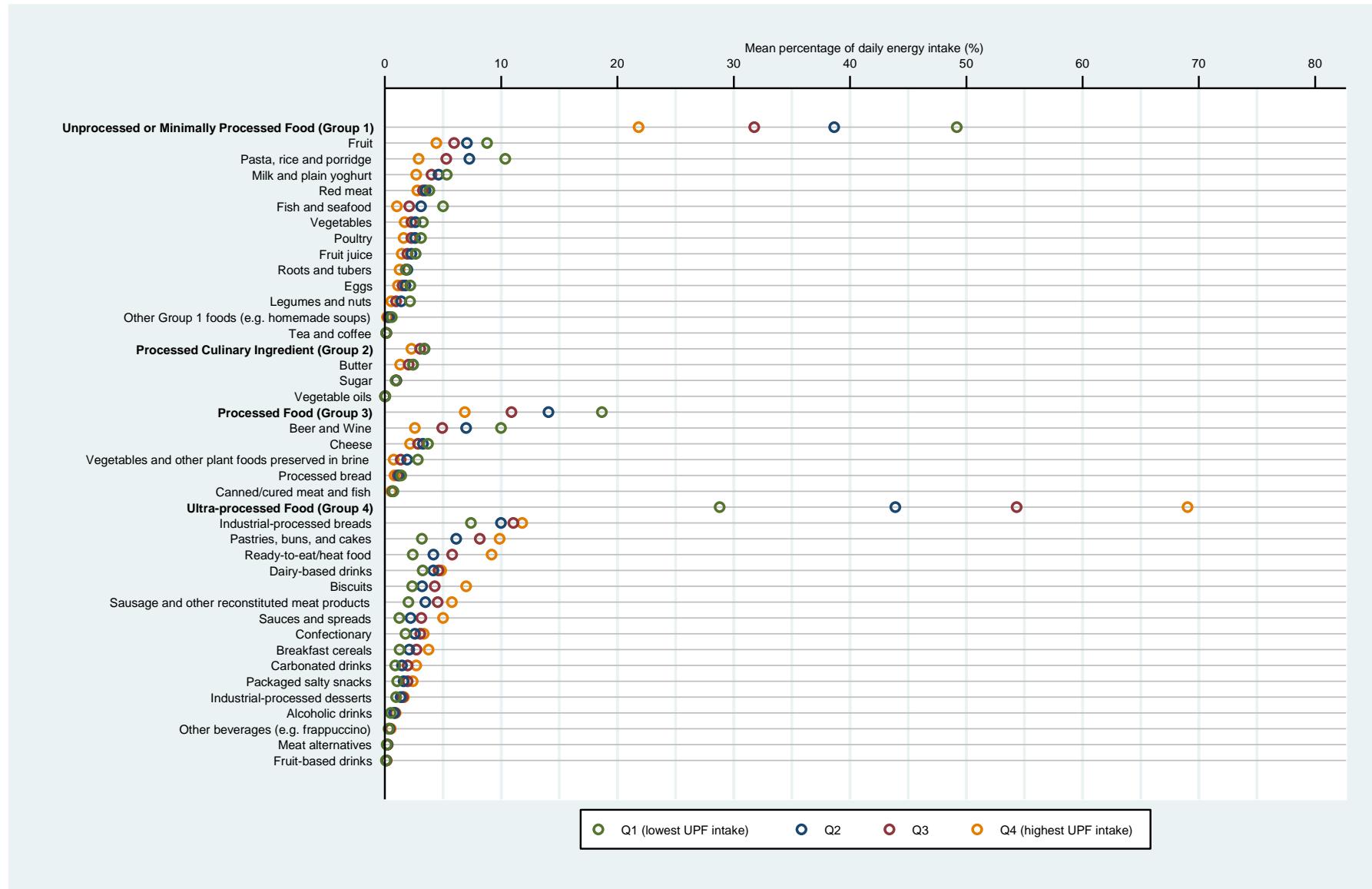
[†]Modelling for breast, uterus and ovarian cancers were conducted in women only (n=107919), modelling for prostate cancer were conducted in men only (n= 89507).

[‡] $P < 0.05$

[§] $P < 0.01$

[¶] $P < 0.001$

Figure S4: Sources of NOVA subgroups based on total energy intake by quartile of UPF consumption



Abbreviations: UPF, ultra-processed food.

UPF consumption was defined as the percentage of its calorie contribution relative to total energy intake measured in kcal/day. Study participants were further categorized into quartiles (Q1-Q4 represents lowest to highest quartile of UPF consumption).

Table S6: Association of cancer incidence by levels of UPF consumption based on total energy intake

Cancer site	Number of incident cases	per 10% increment in UPF intake* HR (95% CI)	Quartile of UPF consumption*				P_{Trend}
			Q1 (lowest) Ref	Q2	Q3	Q4 (highest)	
All cancers	15921	1·01 (1·00-1·02)‡	1	1·04 (0·99-1·09)	1·02 (0·97-1·07)	1·05 (1·00-1·11)‡	0·08
Head and Neck	342	0·91 (0·85-0·99)	1	0·67 (0·49-0·93)‡	0·58 (0·41-0·82)§	0·77 (0·55-1·07)	0·08
Oral cavity	106	0·94 (0·82-1·08)	1	0·90 (0·49-1·62)	1·00 (0·55-1·84)	0·95 (0·51-1·75)	0·95
Oropharynx	86	0·92 (0·78-1·08)	1	0·72 (0·38-1·35)	0·43 (0·21-0·90)‡	0·69 (0·35-1·36)	0·14
Gastrointestinal	2937	1·01 (0·98-1·03)	1	0·97 (0·87-1·09)	1·03 (0·91-1·15)	0·98 (0·87-1·11)	0·91
Oesophagus	283	1·07 (0·97-1·17)	1	1·21 (0·84-1·76)	1·18 (0·81-1·73)	1·24 (0·83-1·85)	0·33
Adenocarcinoma	186	1·02 (0·91-1·14)	1	1·19 (0·75-1·88)	1·21 (0·75-1·93)	1·03 (0·63-1·70)	0·87
Squamous cell carcinoma	67	1·07 (0·89-1·30)	1	1·55 (0·73-3·29)	0·99 (0·43-2·27)	1·54 (0·67-3·52)	0·53
Stomach	189	1·03 (0·93-1·15)	1	1·04 (0·65-1·68)	1·45 (0·92-2·30)	1·00 (0·61-1·64)	0·68
Stomach cardia	75	1·02 (0·85-1·21)	1	0·96 (0·45-2·04)	1·36 (0·67-2·73)	0·80 (0·35-1·79)	0·90
Stomach non-cardia	48	1·01 (0·81-1·25)	1	0·99 (0·39-2·52)	1·10 (0·43-2·80)	0·88 (0·33-2·33)	0·85
Small intestine	77	1·16 (0·98-1·38)	1	2·35 (1·04-5·31)‡	2·63 (1·18-5·85)‡	2·13 (0·90-5·02)	0·09
Colorectal	1670	1·00 (0·97-1·04)	1	0·91 (0·78-1·05)	0·97 (0·84-1·13)	0·99 (0·84-1·16)	0·88
Colon	1091	1·02 (0·98-1·07)	1	0·90 (0·74-1·09)	1·01 (0·84-1·22)	1·06 (0·87-1·29)	0·35
Rectum	579	0·96 (0·91-1·03)	1	0·92 (0·72-1·18)	0·90 (0·70-1·17)	0·85 (0·65-1·12)	0·28
Anal	60	1·10 (0·91-1·33)	1	1·65 (0·73-3·70)	1·45 (0·61-3·43)	1·94 (0·83-4·57)	0·18
Hepatobiliary tract	243	0·99 (0·89-1·09)	1	1·06 (0·70-1·59)	1·05 (0·69-1·59)	0·91 (0·58-1·42)	0·69
Liver	157	0·99 (0·88-1·13)	1	0·80 (0·48-1·35)	1·00 (0·60-1·66)	0·84 (0·49-1·46)	0·76
Hepatocellular carcinoma	74	1·09 (0·90-1·31)	1	1·58 (0·67-3·70)	1·79 (0·78-4·12)	1·53 (0·64-3·65)	0·37
Intrahepatic bile duct	67	0·88 (0·71-1·08)	1	0·50 (0·23-1·09)	0·50 (0·22-1·12)	0·50 (0·20-1·20)	0·11
Pancreas	386	0·95 (0·88-1·03)	1	0·86 (0·63-1·17)	0·82 (0·60-1·14)	0·73 (0·52-1·02)	0·07
Lung	935	1·02 (0·97-1·07)	1	0·94 (0·75-1·16)	1·09 (0·88-1·34)	1·14 (0·92-1·42)	0·12
Melanoma skin	974	1·01 (0·97-1·06)	1	1·07 (0·88-1·30)	0·94 (0·77-1·15)	1·26 (1·02-1·54)‡	0·09
Kidney	451	1·00 (0·93-1·07)	1	1·02 (0·76-1·37)	0·93 (0·69-1·26)	0·97 (0·71-1·32)	0·74
Kidney, except renal pelvis	413	1·00 (0·93-1·07)	1	1·01 (0·74-1·38)	0·97 (0·71-1·32)	0·96 (0·69-1·32)	0·74
Renal cell carcinoma	130	1·09 (0·96-1·24)	1	1·36 (0·74-2·52)	1·55 (0·86-2·80)	1·56 (0·85-2·83)	0·15
Bladder	320	1·00 (0·91-1·09)	1	1·11 (0·77-1·59)	1·29 (0·89-1·85)	0·93 (0·63-1·39)	0·95
Brain and central nervous system	284	1·03 (0·94-1·13)	1	1·06 (0·74-1·53)	1·01 (0·70-1·47)	1·28 (0·87-1·87)	0·26
Brain	277	1·03 (0·94-1·13)	1	1·05 (0·72-1·51)	1·03 (0·71-1·50)	1·26 (0·85-1·85)	0·28
Glioma	242	1·02 (0·93-1·13)	1	1·19 (0·80-1·76)	1·07 (0·71-1·61)	1·21 (0·79-1·84)	0·49
Thyroid	126	1·06 (0·93-1·22)	1	1·41 (0·78-2·53)	1·69 (0·94-3·04)	1·25 (0·66-2·35)	0·42
Lymphatic & haematopoietic tissue	1429	1·04 (1·00-1·08)‡	1	1·13 (0·96-1·33)	1·05 (0·89-1·24)	1·19 (1·00-1·41)‡	0·11
Non-Hodgkin lymphoma	1091	1·03 (0·98-1·07)	1	1·12 (0·93-1·35)	1·01 (0·83-1·22)	1·13 (0·93-1·38)	0·39
Diffuse large B-cell lymphoma	210	1·05 (0·95-1·16)	1	1·73 (1·11-2·69)‡	1·25 (0·77-2·01)	1·43 (0·88-2·31)	0·47
Follicular lymphoma	154	1·00 (0·88-1·13)	1	1·03 (0·63-1·69)	0·91 (0·54-1·54)	1·17 (0·68-2·00)	0·68
CLL/SLL	226	1·01 (0·92-1·11)	1	0·79 (0·53-1·20)	1·01 (0·68-1·50)	1·00 (0·66-1·51)	0·74
Multiple myeloma	286	1·04 (0·95-1·13)	1	1·22 (0·84-1·78)	0·93 (0·63-1·38)	1·24 (0·84-1·83)	0·56
Leukaemia	400	1·01 (0·94-1·09)	1	0·80 (0·58-1·09)	1·08 (0·80-1·46)	0·98 (0·71-1·35)	0·60
Breast†	3030	1·00 (0·97-1·02)	1	1·07 (0·96-1·19)	1·05 (0·94-1·18)	1·02 (0·91-1·15)	0·68
Pre-menopausal breast†	717	0·98 (0·93-1·04)	1	1·18 (0·93-1·50)	0·97 (0·76-1·25)	1·03 (0·80-1·32)	0·79
Post-menopausal breast†	1856	1·01 (0·97-1·04)	1	1·04 (0·91-1·19)	1·06 (0·92-1·23)	1·03 (0·89-1·20)	0·55
Uterus†	439	1·02 (0·96-1·10)	1	1·09 (0·82-1·46)	1·05 (0·78-1·41)	1·25 (0·93-1·69)	0·19
Endometrium†	429	1·03 (0·96-1·11)	1	1·13 (0·84-1·52)	1·07 (0·79-1·44)	1·28 (0·94-1·74)	0·16
Ovary†	291	1·11 (1·02-1·22)‡	1	1·35 (0·92-1·98)	1·45 (0·99-2·12)	1·41 (0·94-2·10)	0·09
Prostate†	3621	0·99 (0·97-1·02)	1	1·02 (0·92-1·13)	0·94 (0·85-1·04)	0·98 (0·88-1·09)	0·44

Abbreviations: UPF, ultra-processed food; HR, hazard ratio; CI, confidence interval; Ref, reference category; CLL, Chronic lymphocytic leukemia; SLL, Small lymphocytic lymphoma.

All models were fully adjusted with age (underlying timescale), ethnicity, smoking status, physical activity level, average household income, highest educational attainment, alcohol intake, body mass index, and stratified by sex, height, family history of cancer, index of multiple deprivation quintile, and geographical region. Analyses of female-specific cancers were additionally adjusted for baseline menopausal status, use of oral contraceptives, use of hormone replacement therapy, and parity.

*UPF consumption was defined as the percentage of its calorie contribution relative to total energy intake measured in kcal/day. Study participants were further categorized into quartiles (Q1-Q4 represents lowest to highest quartile of UPF consumption).

†Modelling for breast, uterus and ovarian cancers were conducted in women only (n=107919), modelling for prostate cancer were conducted in men only (n= 89507).

‡ $P < 0.05$

§ $P < 0.01$

Table S7: Association of cancer-related mortality by levels of UPF consumption based on total energy intake

Cancer site	Number of deaths	per 10% increment in UPF intake* HR (95% CI)	Quartile of UPF consumption*				P_{Trend}
			Q1 (lowest) Ref	Q2 HR (95% CI)	Q3 HR (95% CI)	Q4 (highest) HR (95% CI)	
All cancers	4009	1·03 (1·00-1·05)§	1	1·10 (1·00-1·22)‡	1·10 (0·99-1·21)	1·13 (1·01-1·25)‡	0·03
Head and Neck	54	1·01 (0·81-1·26)	1	0·40 (0·14-1·13)	1·12 (0·47-2·67)	1·24 (0·50-3·05)	0·33
Gastrointestinal	1408	1·00 (0·96-1·04)	1	1·05 (0·89-1·24)	1·01 (0·86-1·20)	0·96 (0·80-1·15)	0·62
Oesophagus	194	1·14 (1·02-1·28)‡	1	1·68 (1·03-2·71)‡	1·70 (1·04-2·79)‡	1·74 (1·04-2·91)‡	0·05
Stomach	121	1·01 (0·89-1·16)	1	1·39 (0·77-2·51)	1·14 (0·62-2·10)	1·11 (0·60-2·07)	0·96
Colorectal	438	0·98 (0·91-1·05)	1	1·01 (0·75-1·35)	0·98 (0·73-1·32)	0·88 (0·64-1·22)	0·47
Colon	244	1·02 (0·92-1·12)	1	0·97 (0·64-1·47)	1·22 (0·82-1·82)	0·91 (0·58-1·42)	0·99
Rectum	194	0·94 (0·84-1·04)	1	1·05 (0·69-1·60)	0·69 (0·43-1·10)	0·85 (0·53-1·35)	0·24
Hepatobiliary tract	182	1·00 (0·89-1·13)	1	0·87 (0·53-1·43)	1·04 (0·64-1·70)	0·87 (0·52-1·47)	0·83
Liver	150	0·97 (0·86-1·11)	1	0·76 (0·45-1·30)	0·85 (0·50-1·45)	0·73 (0·41-1·29)	0·39
Hepatocellular carcinoma	46	1·10 (0·85-1·41)	1	1·22 (0·40-3·66)	1·54 (0·50-4·76)	1·31 (0·41-4·20)	0·59
Intrahepatic bile duct	103	0·93 (0·79-1·08)	1	0·61 (0·32-1·15)	0·63 (0·33-1·18)	0·58 (0·29-1·16)	0·14
Pancreas	371	0·95 (0·88-1·02)	1	0·87 (0·64-1·19)	0·78 (0·56-1·08)	0·73 (0·52-1·03)	0·05
Lung	633	1·05 (0·99-1·12)	1	1·02 (0·78-1·33)	1·18 (0·90-1·53)	1·27 (0·97-1·67)	0·05
Melanoma skin	63	1·11 (0·91-1·34)	1	1·34 (0·61-2·92)	0·60 (0·24-1·52)	1·72 (0·75-3·97)	0·54
Kidney	117	1·03 (0·90-1·18)	1	1·11 (0·63-1·96)	1·06 (0·58-1·90)	1·18 (0·65-2·15)	0·64
Bladder	112	1·01 (0·86-1·18)	1	0·73 (0·40-1·33)	0·80 (0·43-1·49)	0·85 (0·45-1·62)	0·76
Brain and central nervous system	251	1·02 (0·93-1·12)	1	0·94 (0·64-1·38)	0·98 (0·66-1·44)	1·14 (0·76-1·71)	0·49
Lymphatic & haematopoietic tissue	376	1·07 (0·99-1·16)	1	1·24 (0·88-1·74)	1·25 (0·88-1·78)	1·38 (0·97-1·97)	0·09
Non-Hodgkin lymphoma	141	1·13 (0·99-1·29)	1	1·87 (1·04-3·37)‡	1·52 (0·81-2·83)	2·05 (1·11-3·81)‡	0·07
Multiple myeloma	91	1·14 (0·96-1·35)	1	2·12 (0·98-4·58)	1·56 (0·69-3·51)	2·38 (1·07-5·29)‡	0·09
Leukaemia	137	0·96 (0·84-1·10)	1	0·70 (0·41-1·22)	1·05 (0·62-1·78)	0·73 (0·41-1·29)	0·57
Breast†	176	1·02 (0·91-1·14)	1	1·02 (0·65-1·61)	1·24 (0·78-1·97)	1·17 (0·71-1·94)	0·40
Post-menopausal†	120	0·98 (0·85-1·14)	1	0·85 (0·48-1·51)	1·18 (0·66-2·13)	1·01 (0·53-1·93)	0·75
Uterus†	61	0·99 (0·79-1·22)	1	1·00 (0·44-2·26)	0·78 (0·32-1·89)	1·08 (0·43-2·68)	0·95
Endometrium†	43	0·99 (0·76-1·29)	1	0·98 (0·37-2·61)	0·94 (0·32-2·71)	1·07 (0·34-3·29)	0·93
Ovary†	143	1·20 (1·05-1·37)§	1	1·48 (0·84-2·62)	1·59 (0·90-2·81)	1·79 (1·00-3·23)	0·06
Prostate†	194	0·94 (0·84-1·06)	1	1·04 (0·67-1·63)	0·84 (0·53-1·35)	0·96 (0·59-1·56)	0·68

Abbreviations: UPF, ultra-processed food; HR, hazard ratio; CI, confidence interval; Ref, reference category; CLL, Chronic lymphocytic leukemia; SLL, Small lymphocytic lymphoma.

All models were fully adjusted with age (underlying timescale), ethnicity, smoking status, physical activity level, average household income, highest educational attainment, alcohol intake, body mass index, and stratified by sex, height, family history of cancer, index of multiple deprivation quintile, and geographical region. Analyses of female-specific cancers were additionally adjusted for baseline menopausal status, use of oral contraceptives, use of hormone replacement therapy, and parity.

*UPF consumption was defined as the percentage of its calorie contribution relative to total energy intake measured in kcal/day. Study participants were further categorized into quartiles (Q1-Q4 represents lowest to highest quartile of UPF consumption).

†Modelling for breast, uterus and ovarian cancers were conducted in women only (n=107919), modelling for prostate cancer were conducted in men only (n= 89507).

‡ $P < 0·05$

§ $P < 0·01$